

[00124] WHAT IS CLAIMED IS:

1. ~~A system for determining the spatial placement, including position and orientation, of a plurality of body parts of living beings, said body parts acting as individual articulated elements of a kinematically constrained multi-articulated structure comprising at least two links and at least two revolute joints, two joints separated by a single link, said system comprising:~~

~~a plurality of position-sensing elements disposed about said articulated structure, wherein at least one of said links does not include an affixed position-sensing element, wherein said position-sensing elements either are a transmitter which transmits a signal or a receiver which receives said signal, wherein said position-sensing elements are disposed in juxtaposition to links to provide measured links;~~

~~optionally a position-sensing element attached to a reference location;~~

~~wherein said position-sensing elements include at least one transmitter and at least one receiver;~~

~~an analog data processing means for driving said transmitters to produce said signal and amplifying and digitizing said signals received by said receivers;~~

~~a digital data processing means utilizing said digitized signals for calculating the spatial placement of said position-sensing elements;~~

~~means for determining the spatial placement of all of the articulated elements of said links utilizing the spatial placement of said measured links as determined from said digital data processing means and the kinematic constraints of the multi-articulated elements of said system.~~

2. ~~A system for determining the spatial placement, including position and orientation, of a plurality of body parts of living beings, said body parts acting as individual articulated elements of a kinematically constrained multi-articulated structure comprising at least three links and at least three revolute joints, two joints separated by a single link, said system comprising:~~

~~a plurality of sensing elements consisting of position-sensing elements and single joint position sensors disposed about said articulated structure, wherein at least one of said links does not include an affixed sensing element wherein said position-sensing elements either use a transmitter which transmits a first signal or a receiver which receives said first signal, wherein said position-sensing elements are disposed in juxtaposition to links to provide measured links, wherein each said single joint position sensor is a goniometer which produces a second signal, wherein said goniometers are disposed in juxtaposition to revolute joints;~~

~~optionally a position-sensing element attached to a reference location;~~

~~wherein said position-sensing elements include at least one transmitter and at least one receiver;~~

~~an analog data processing means for driving said transmitters and amplifying and digitizing said first signals received by said receivers and for digitizing said second signals from said goniometers;~~

~~a digital data processing means utilizing said digitized signals for calculating the spatial placement of said sensing elements;~~

~~means for determining the spatial placement of all of the articulated elements of said links utilizing the spatial placement of said measured links as determined from said digital data processing means and the kinematic constraints of the articulated elements of said system.~~

3. ~~A system for determining the spatial placement, including position and orientation, of individual articulated elements comprising joints and links of the hand and wrist, said system comprising:~~

~~a plurality of sensing elements, consisting of position-sensing elements and goniometers, disposed about said hand and wrist, wherein at least one of said links does not include an affixed sensing element, wherein said position-sensing elements either are a transmitter which transmits a signal or a receiver which receives said signal, wherein said sensing elements are disposed in rigid juxtaposition to links to provide measured links consisting of the combinations of A and B:~~

~~A is one of (1) the fingertips of the fingers and the thumb, or (2) the medial phalanges of the four fingers and the proximal phalanx of the thumb and goniometers over the distal interphalangeal joints or combinations thereof; and~~

~~B is one of (3) the dorsal side of the metacarpus and the forearm in proximity to the wrist or (4) one of (i) the dorsal side of the metacarpus and (ii) the forearm in proximity to the wrist, with two goniometer elements positioned on said wrist, wherein one of said goniometers measures flexion/extension and the other measures abduction/adduction;~~

~~optionally a position-sensing element attached to a reference location;~~

~~wherein said position-sensing elements include at least one transmitter and at least one receiver;~~

~~an analog data processing means for driving said transmitters to produce said signal, amplifying and digitizing said signals received by said receivers and received by said analog data processing means from said goniometer elements;~~

~~a digital data processing means utilizing said digitized signals for calculating the spatial placement of said sensing elements;~~

~~means for determining the spatial placement of all of the articulated elements of said hand and wrist utilizing the spatial placement of said measured links as determined from said digital data processing means and the kinematic constraints the articulated elements of said hand and of wrist.~~

4. ~~A system according to Claim 3, wherein at least one of said position sensors is on the medial phalanx of a first finger of one of the four fingers; and~~

~~further including a goniometer disposed on the distal interphalangeal joint of said first finger.~~

5. ~~A system for determining the spatial placement, including position and orientation, of individual articulated elements comprising joints and links of the hand and wrist, said system comprising:~~

~~a plurality of position sensing elements disposed about said hand and wrist, wherein at least one of said links does not include an affixed sensing element, wherein said position sensing elements either are a transmitter which transmits a signal or a receiver which receives said signal, wherein said sensing elements are disposed in rigid juxtaposition to links to provide measured links consisting of: (1) the fingertips of the fingers and the thumb, or (2) the medial phalanges of the four fingers and the proximal phalanx of the thumb; the dorsal side of the metacarpus, the forearm in proximity to the wrist;~~

~~optionally a sensing element attached to a reference location;~~

~~wherein said sensing elements include at least one transmitter and at least one receiver;~~

~~an analog data processing means for driving said transmitters to produce said signal and amplifying and digitizing said signals received by said receivers;~~

~~a digital data processing means utilizing said digitized signals for calculating the spatial placement of said sensing elements;~~

~~means for determining the spatial placement of all of the articulated elements of said hand and wrist utilizing the spatial placement of said measured links as determined from said digital data processing means and the kinematic constraints of the articulated elements of said hand and wrist.~~

6. ~~A system for determining the spatial placement, including position and orientation, of individual articulated elements comprising joints and links of the hand and wrist, said system comprising:~~

~~a plurality of sensing elements consisting of position sensing elements and goniometers disposed about said hand and wrist, wherein at least one of said links does not include an affixed sensing element, wherein said position sensing elements either are a transmitter which transmits a signal or a receiver which receives said signal, wherein said sensing elements are disposed in rigid juxtaposition to links to provide measured links consisting of: (1) the fingertips of the fingers and the thumb, or (2) the medial phalanges of the four fingers and the proximal phalanx of the thumb; and (3) the dorsal side of the metacarpus or (4) the forearm in proximity to the wrist;~~

~~optionally a position sensing element attached to a reference location;~~

~~wherein said position sensing elements include at least one transmitter and at least one receiver;~~

~~two goniometers positioned on said wrist, wherein one of said goniometers measures flexion/extension and the other measures abduction/adduction;~~

~~an analog data processing means for driving said transmitters to produce said signal, amplifying and digitizing said signals received by said receivers and received by said analog data processing means from said goniometer elements;~~

~~a digital data processing means utilizing said digitized signals for calculating the spatial placement of said sensing elements;~~

~~means for determining the spatial placement of all of the articulated elements of said hand and wrist utilizing the spatial placement of said measured links as determined from said digital data processing means and the kinematic constraints of the articulated elements of said hand and wrist.~~

~~7. — A system according to Claim 6, wherein at least one of said position sensors is on the medial phalanx of a first finger of one of the four fingers; and~~

~~further including a goniometer disposed on the distal interphalangeal joint of said first finger.~~

~~8. — A system for determining the spatial placement, including position and orientation, of individual articulated elements comprising joints and links of the hand and wrist, said system comprising:~~

~~a plurality of position sensing elements, disposed about said hand and wrist, wherein at least one of said links does not include an affixed sensing element, wherein said position sensing elements either are a transmitter which transmits a signal or a receiver which receives said signal, wherein said sensing elements are disposed in rigid juxtaposition to links to provide measured links consisting of the combinations of A and B:~~

~~A is one of (1) the fingertips of the fingers and the thumb, or (2) the medial phalanges of the four fingers and the proximal phalanx of the thumb and goniometers over the distal interphalangeal joints or combinations thereof; and~~

~~B is one of (3) the dorsal side of the metacarpus and the forearm in proximity to the wrist or (4) one of (i) the dorsal side of the metacarpus and (ii) the forearm in proximity to the wrist, with two goniometer elements positioned on said wrist, wherein one of said goniometers measures flexion/extension and the other measures abduction/adduction;~~

~~optionally a position sensing element attached to a reference location,~~

~~wherein said position sensing elements include at least one transmitter and at least one receiver;~~

~~an analog data processing means for driving said transmitters to produce said signal, amplifying and digitizing said signals received by said receivers and received by said analog data processing means from said goniometer elements;~~

~~a digital data processing means utilizing said digitized signals for calculating the spatial placement of said sensing elements;~~

~~means for determining the spatial placement of all of the articulated elements of said hand and wrist utilizing the spatial placement of said measured links as determined from said digital data processing means and the kinematic constraints of the articulated elements of said hand and wrist.~~

~~DETERMINATION OF KINEMATICALLY CONSTRAINED  
MULTI-ARTICULATED STRUCTURES~~